REMARKS

Favorable reconsideration of this application is respectfully requested in light of the following remarks.

By way of the foregoing amendments to the specification, the title of the invention has been replaced. In particular, a new title has been added that is clearly indicative of the invention. In addition, the specification has also been amended to correct an inadvertent error. In particular, on page 11, line 15, the word "orthogonally" has been replaced with the word "parallely". Applicants submit that one having ordinary skill in the art would necessarily find that the above-described text was a mistake. See Figure 1 in conjunction with Figure 4. In particular, one having ordinary skill in the art would find that given a deviation δ in the phase delay φ of the $\lambda/4$ segment of 90°, the reflection interferometer behaves like a Sagnac interferometer with two identical $\lambda/4$ segments whose axes are aligned parallely. It follows, in analogy to equation 7, that equation 9 will read

$$\Delta\Phi'_{R} \approx \Delta\Phi_{R} [1 + \delta^2/2) \qquad (9).$$

As a consequence, the calculated angle on page 11, line 22 is not 75° but 105°. This flows straight from the corrected Equation 9. Thus, the correction to the specification merely corrects language which one having ordinary skill in the art would recognize as a mistake. Thus, the above amendments add no new matter.

Claims 1-9 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

By way of the foregoing claim amendment, Claims 1-9 have been amended. In addition, new independent Claim 10 has been added to the application.

Claims 1-9 have been amended to conform the claims to U.S. practice. In addition, Claim 4 has been amended to remove the indefiniteness noted by the Examiner. In particular, Claim 4 has been amended to clarify that the current sensor includes at least two phase delay elements, each having a fast axes. In addition, Claims 6 and 7 have been amended to conform the claims to the specification. Support for the changes to Claims 6 and 7 may be found in particular in the examples given in the text on page 9, line 26 to page 10, line 12. However, with regard to the Examiner's allegation that it is unclear what a "beat length of orthogonal polarization modes" represents, Applicants direct the Examiner's attention to the description at page 7, lines 2-10, wherein it is explained what a beat length is. Applicants also direct the Examiner's attention to page 5, lines 3-27 which provide further guidance as to meaning of that term. This term is known to a person having ordinary skill in the art of fiber optics. Accordingly, withdrawal of the rejections based on 35 U.S.C. § 112, second paragraph, is respectfully requested.

Claims 1-2 and 5-7 stand rejected under 35 U.S.C. § 102(b) as being anticipated by WO 98/58268 to *Blake et al.* Claims 1-3 and 6-7 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,953,121 to *Bohnert et al.*

The disclosed embodiment of the preferred embodiment pertains to a fiber optic current sensor. The sensor includes a coiled sensor fiber which encloses a current conductor. At least one phase delay element adjoins the sensor fiber. The at least one phase delay element has a phase delay with a temperature dependence which at least

approximately compensates for a temperature dependence of a Verdet's constant of the sensor fiber. These features are defined in independent Claims 1 and 10.

The above-described sensor solves a problem in the art with respect to current measurement. In particular, in the development of prior art sensor fibers, prior art designers have not taken into account that the Verdet's constant exhibits a temperature dependence which is noticeable even in the case of an ideal-stress free fiber coil. This is particularly relevant for applications of the current sensor and high-voltage installation where there is a need for a substantially higher accuracy of current measurement. The present invention solves this problem by providing at least one phase delay element which has a phase delay with a temperature dependence which at least approximately compensates for a temperature dependence of a Verdet's constant of the sensor fiber as defined in independent Claims 1 and 10.

In one preferred embodiment, non limiting embodiment, the compensation comes about by virtue of the fact that the phase delay element has an appropriate phase delay angle which deviates from a phase delay angle of an ideal phase delay element. These features are defined in independent Claim 10. None of the art of record disclose these patentable features.

In contrast, *Blake et al.* describes ways to compensate for influences of linear birefringence of the sensing fiber. As mentioned in *Blake et al.* on page 2, line 7, page 8, line 24, and page 10, line 22, changes in temperature may cause changes in birefringence in the sensing fiber. But *Blake et al.* does not recognize the temperature dependence of the Verdet's constant of the sensing fiber, nor does *Blake et al.* mention any means to

compensate for this temperature dependence. Accordingly, *Blake et al.* fails to disclose the feature of at least one phase delay element having a phase delay with a temperature dependence which at least approximately compensates for a temperature dependence of a Verdet's constant of the sensor fiber, as defined in independent Claims 1 and 10.

In addition, *Blake et al.* fails to describe that at least one phase delay element has a phase delay angle whose value deviates from a phase delay angle of an ideal phase delay element, as defined in independent Claim 10. As described on page 6, lines 16-20 of *Blake et al.*, the phase element (40) is ideally a quarter of a polarization beat length long. In *Blake et al.* there is absolutely no mention of a phase delay angle of the phase delay element would deviate from the phase delay angle of an ideal phase delay element. Accordingly, *Blake et al.* fails to disclose the patentable features of independent Claim 10.

Similarly, *Bohnert et al.* fails to disclose the patentable features of independent Claims 1 and 10. In particular, *Bohnert et al.* describes ways to provide a temperature compensation for a magneto-optic current sensor. The temperature effects that are compensated for in *Bohnert et al.* are changes of the linear birefringence of the sensing fiber (sensor coil) with temperature. In *Bohnert et al.*, the sensing fibers are largely free from mechanical stress and therefore approximately free from linear birefringence. See *Bohnert et al.*, column 4, lines 24-26 and column 6, lines 6-9. Therefore, only negligible changes of linear birefringence of the sensing coil occur upon temperature changes.

In addition, at column 5, lines 45-51 *Bohnert et al.* discloses that the length of the phase delay element ($\lambda/4$ time delay element) may deviate from the ideal value by a tolerance angle δ. A tolerance is a randomized allowed deviation from an optimum value,

so as to allow for an efficient production at acceptable function and other imperfection.

Such a tolerance angle cannot anticipate a phase delay element that "has a phase delay with

a temperature dependence which at least approximately compensates for a temperature

dependence of a Verdet's constant (V) of the sensor fiber (1)", as defined in Claims 1 and

10. Likewise, *Bohnert et al.* does not disclose the feature of a phase delay element that

"has a phase delay angle whose value deviates from a phase delay angle of an ideal phase

delay element", as defined in independent Claim 10. The optimum value for the length of

the phase delay element according to Claim 10 is such that its phase delay angle

deliberately and specifically deviates from the phase delay angle of an ideal phase delay

element. This deviation is not by random and/or to compensate for productional or other

imperfections. Therefore the tolerance angle δ and phase delay element length in *Bohnert*

et al. does not anticipate the angle and/or length of the phase delay element according to

the invention. Accordingly, *Bohnert et al.* fails to disclose the patentable features of

independent Claim 10.

For at least the foregoing reasons, it is submitted that the current sensor of

independent Claims 1 and 10, and the claims depending therefrom, is patentably

distinguishable over the applied documents. Accordingly, withdrawal of the rejections of

record and allowance of this application are earnestly solicited.

Should any questions arise in connection with this application, or should the

Examiner believe a telephone conference would be helpful in resolving any remaining

issues pertaining to this application, the undersigned respectfully requests that she be

contacted at the number indicated below.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: _Elaine P. Spector_

Elaine P. Spector
Registration No. 40,116

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Date: July 29, 2002

Attachment to Amendment dated July 29, 2002

Kindly amend the Title of the Invention as follows:

TEMPERATURE-COMPENSATED FIBER OPTIC CURRENT SENSOR.

Page 11, Paragraph Beginning at Line 5:

A fiber optic current sensor with a reflection interferometer is illustrated in figure 4. By contrast with the abovedescribed Sagnac interferometer, this current sensor has no return fiber, but an end of a sensor fiber 1 averted from the feed fiber 3 is designed as reflector 3'. As regards the temperature composition, this configuration forms a special case of the current sensor in accordance with figure 1. Given a deviation δ in the phase delay φ of the λ/4 segment of 90°, the reflection interferometer behaves like a Sagnac interferometer with two identical λ/4 segments whose axes are aligned [orthogonally] parallely. The current-induced differential phase shift is then approximately

$$\Delta\Phi'{}_R \approx \Delta\Phi_R\ [1[-]\pm\ \delta^2/2)\qquad\qquad (9).$$

$\Delta\Phi_R$ is given by equation (2). If the temperature dependence of the phase delay of the λ/4 segment is -0.0153°/°C, as in the above example, the phase delay angle is to be set to [75°] 105° at room temperature, and the length L of the segment is to be selected correspondingly in order to achieve compensation of the temperature dependence of the Verdet's constant V.

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Marked-up Claims 1-9

1. (Twice Amended) A fiber optic current sensor, comprising: [having] a coiled sensor fiber which encloses a current conductor (S), and at least one phase delay element adjoining the sensor fiber, [characterized in that] wherein the at least one phase delay element has a phase delay with a temperature dependence which at least approximately compensates for a temperature dependence of a Verdet's constant (V) of the sensor fiber.

2. (Twice Amended) The current sensor as claimed in claim 1, [characterized in that] wherein the at least one phase delay element has a phase delay angle whose value deviates from a phase delay angle of an ideal phase delay element.

3. (Twice Amended) The current sensor as claimed in claim 1, [characterized in that] wherein the at least one phase delay element is a $\lambda/4$ fiber segment with an elliptical core, and in that the $\lambda/4$ fiber segment has a length (L) which deviates from a quarter or an odd multiple of a quarter of a beat length of orthogonal polarization modes.

4. (Twice Amended) The current sensor as claimed in claim 2, [characterized in that] comprising at least two phase delay elements, each having a fast axis, wherein the magnitude of the phase delay angle is selected as a function of a mutual alignment of fast axes of the phase delay [element] elements.

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Marked-up Claims 1-9

5. (Twice Amended) The current sensor as claimed in claim 2, [characterized in that] <u>wherein</u> the magnitude of the phase delay angle is selected as a function of a sign of the temperature dependence of the at least one phase delay element.

6. (Twice Amended) The current sensor as claimed in claim 2, [characterized in that there are] <u>comprising</u> at least two phase delay elements, each having a fast axis, the fast axes being orientated at least approximately parallel to one another, [and in that] <u>wherein the magnitude of the phase delay angle is selected as a function of a mutual alignment of fast axes of the phase delay elements and as a function of a sign of the temperature dependence of the at least one phase delay element, wherein</u> in the case of a temperature dependence of the phase delay elements of [positive] <u>negative</u> sign the phase delay angle is greater, and in the case of a temperature dependence of [negative] <u>positive</u> sign it is smaller than a phase delay angle of an ideal phase delay element.

7. (Twice Amended) The current sensor as claimed in claim 2, [characterized in that there are] <u>comprising</u> at least two phase delay elements, each having a fast axis, the fast axes being orientated at least approximately orthogonally to one another, [and in that] <u>wherein the magnitude of the phase delay angle is selected as a function of a mutual alignment of fast axes of the phase delay elements and as a function of a sign of the temperature dependence of the at least one phase delay element, wherein</u> in the case of a

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Marked-up Claims 1-9

temperature dependence of the phase delay elements of [positive] <u>negative</u> sign the phase

delay angle is smaller, and in the case of a temperature dependence of [negative] <u>positive</u>

sign it is larger than a phase delay angle of an ideal phase delay element.

     8. (Amended) The current sensor as claimed in claim 1, [characterized in that it

has] <u>the current sensor comprising</u> a Sagnac interferometer.

     9. (Amended) The current sensor as claimed in claim 1, [characterized in that it

has] <u>the current sensor comprising</u> a reflection interferometer.